

## C4197 Log Data Report

### Borehole Information:

<b>Borehole:</b> C4197		<b>Site:</b> 216-B-26 Trench			
<b>Coordinates (WA State Plane)</b>		<b>GWL (ft)<sup>1</sup>:</b> Not reached		<b>GWL Date:</b> 11/14/2003	
<b>North</b> n/a <sup>3</sup>	<b>East</b> n/a	<b>Drill Date</b> Nov. 2003	<b>TOC<sup>2</sup> Elevation</b> n/a	<b>Total Depth (ft)</b> 40	<b>Type</b> Percussion

### Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0	6 5/8	5 5/8	1/2	0	
The logging engineer used a caliper to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

### Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe. The ground surface between 0 and about 1 ft is compacted gravel that was trucked in to stabilize the ground surface for drilling and logging operations.

### Logging Equipment Information:

<b>Logging System:</b> Gamma 2A	<b>Type:</b> 35% HPGe (34-TP20863A)
<b>Calibration Date:</b> 09/2002	<b>Calibration Reference:</b> GJO-2002-383-TAC
<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0	

<b>Logging System:</b> Gamma 1C	<b>Type:</b> High Rate Detector
<b>Calibration Date:</b> 04/2003	<b>Calibration Reference:</b> GJO-2003-429-TAC
<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0	

<b>Logging System:</b> Gamma 2F	<b>Type:</b> Moisture (H380932510)
<b>Calibration Date:</b> 09/2003	<b>Calibration Reference:</b> GJO-2003-520-TAC
<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0	

### Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2/Repeat			
Date	11/17/03	11/17/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	39.0	5.0			

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Finish Depth (ft)	1.0	1.0			
Count Time (sec)	200	200			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A <sup>4</sup>	N/A			
Pre-Verification	BA218CAB	BA218CAB			
Start File	BA218000	BA218039			
Finish File	BA218038	BA218043			
Post-Verification	BA219CAA	BA219CAA			
Depth Return Error (in.)	0	0			
Comments	No fine-gain adjustment.	Repeat section.			

**High Rate Logging System (HRLS) Log Run Information:**

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Date	11/26/03	11/26/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	15.0	13.0			
Finish Depth (ft)	11.0	12.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	AC084CAB	AC084CAB			
Start File	AC085000	AC085005			
Finish File	AC085004	AC085006			
Post-Verification	AC085CAA	AC085CAA			
Depth Return Error (in.)	N/A	0			
Comments	No fine-gain adjustment.	Repeat section.			

**Neutron Moisture Logging System (NMLS) Log Run Information:**

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Date	11/17/03	11/17/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	10.0			
Finish Depth (ft)	39.5	14.0			
Count Time (sec)	N/A	N/A			
Live/Real	N/A	N/A			
Shield (Y/N)	N/A	N/A			
MSA Interval (ft)	0.25	0.25			
ft/min	1.0	1.0			
Pre-Verification	BF117CAB	BF116CAB			
Start File	BF117000	BF117159			
Finish File	BF117158	BF117175			
Post-Verification	BF117CAA	BF117CAA			

Log Run	1	2/Repeat			
Depth Return Error (in.)	N/A	0			
Comments	None	Repeat section.			

**Logging Operation Notes:**

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sondes.

SGLS data were collected using Gamma 2A. Pre- and post-survey verification measurements employed the Amersham KUT (<sup>40</sup>K, <sup>238</sup>U, and <sup>232</sup>Th) verifier with serial number 082. Peak counts per second (cps) for <sup>232</sup>Th (2614 keV) were below acceptance criteria for pre-survey verification file BA218CAB.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the <sup>137</sup>Cs verifier with serial number 1013.

During neutron-moisture logging, the data file BF117158 was invalid because the count time was too long. The sonde was resting on the borehole bottom.

**Analysis Notes:**

<b>Analyst:</b>	Sobczyk	<b>Date:</b>	12/01/03	<b>Reference:</b>	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits. Both of the verification spectra were outside the acceptance criteria. The photopeak counts per second (cps) at 2614.5 keV for pre-run spectrum BA218CAB was below the acceptance criteria. The full width half maximum (FWHM) of the 609-, 1461-, and 2615-keV photopeaks were above the control limits for post-run verification spectrum BA219CAA. The FWHM describes peak shape. Examinations of spectra indicate that the peak broadening that occurred during the first log run may have slightly reduced the calculated concentrations above 1200 keV, and the spectra are provisionally accepted.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The verification spectra were within the control limits.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2AFeb03.xls [SGLS] and G1CApr03.xls [HRLS]). Zero reference was the ground surface. On the basis of measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to total logging depth (39 ft). The SGLS and HRLS casing correction factors were calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. A water correction was not required.

Using the SGLS, dead time greater than 40 percent was encountered at depths of 12 and 13 ft, and data from this region are considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time

corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron moisture calibration is based on a typical 6-in. casing with a thickness of 0.28 in., and the neutron moisture values were corrected for the 0.5-in. casing thickness.

### **Log Plot Notes:**

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$  and  $^{125}\text{Sb}$  were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was detected throughout the entire length of the borehole at concentrations ranging from the MDL (0.2 pCi/g) to 18,400 pCi/g. The maximum concentration of  $^{137}\text{Cs}$  was measured at 13 ft.  $^{125}\text{Sb}$  was detected at 19 and 24 ft with concentrations of 1.5 and 1.4 pCi/g, respectively.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data.  $^{137}\text{Cs}$  (662 keV) concentrations are comparable between the repeat and original HRLS log runs.  $^{137}\text{Cs}$  and the natural radionuclides at energy levels of 662, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The neutron-moisture and its repeat are within the acceptance criteria.

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<sup>1</sup> GWL – groundwater level

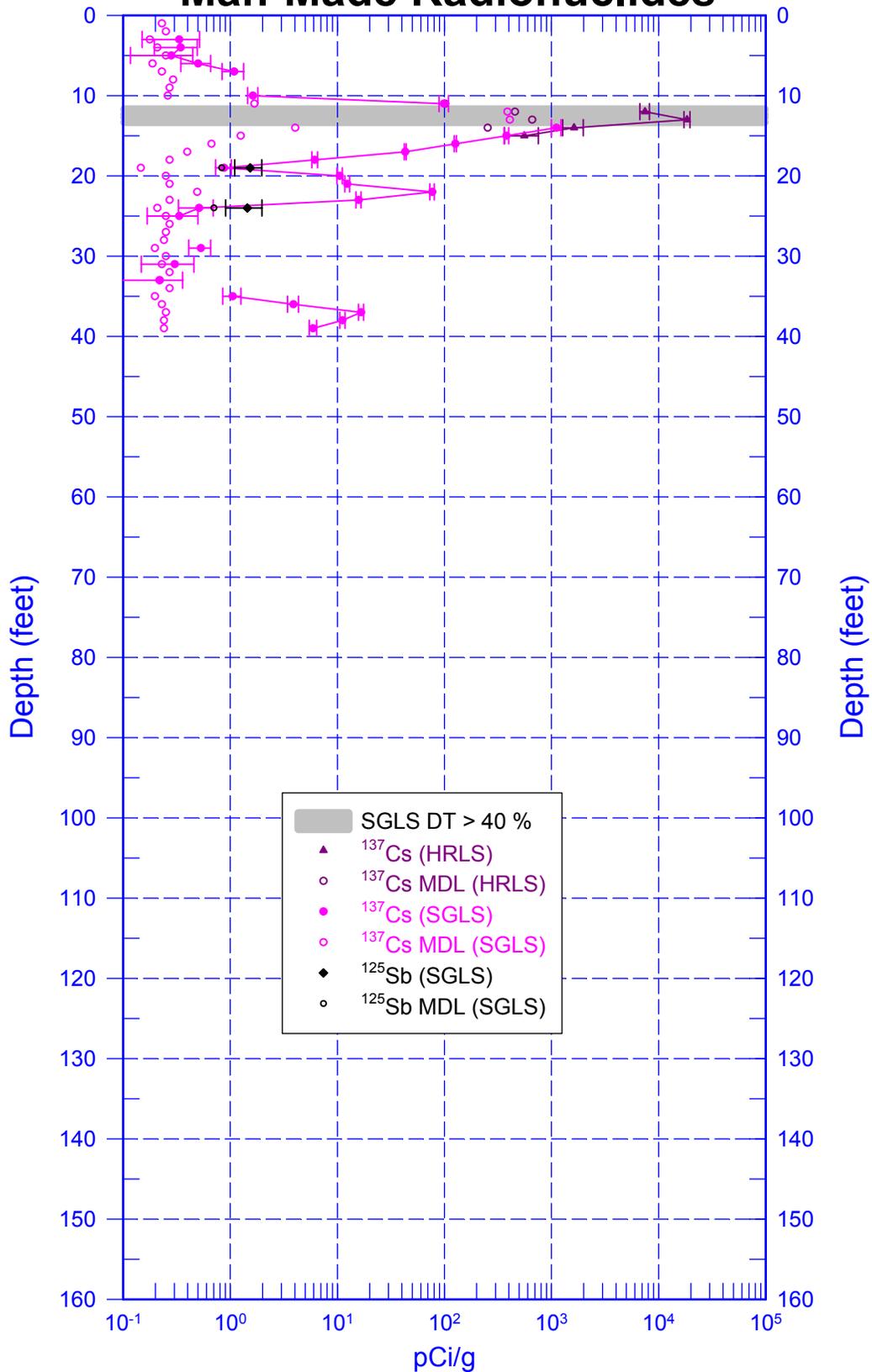
<sup>2</sup> TOC – top of casing

<sup>3</sup> n/a – not available

<sup>4</sup> N/A – not applicable

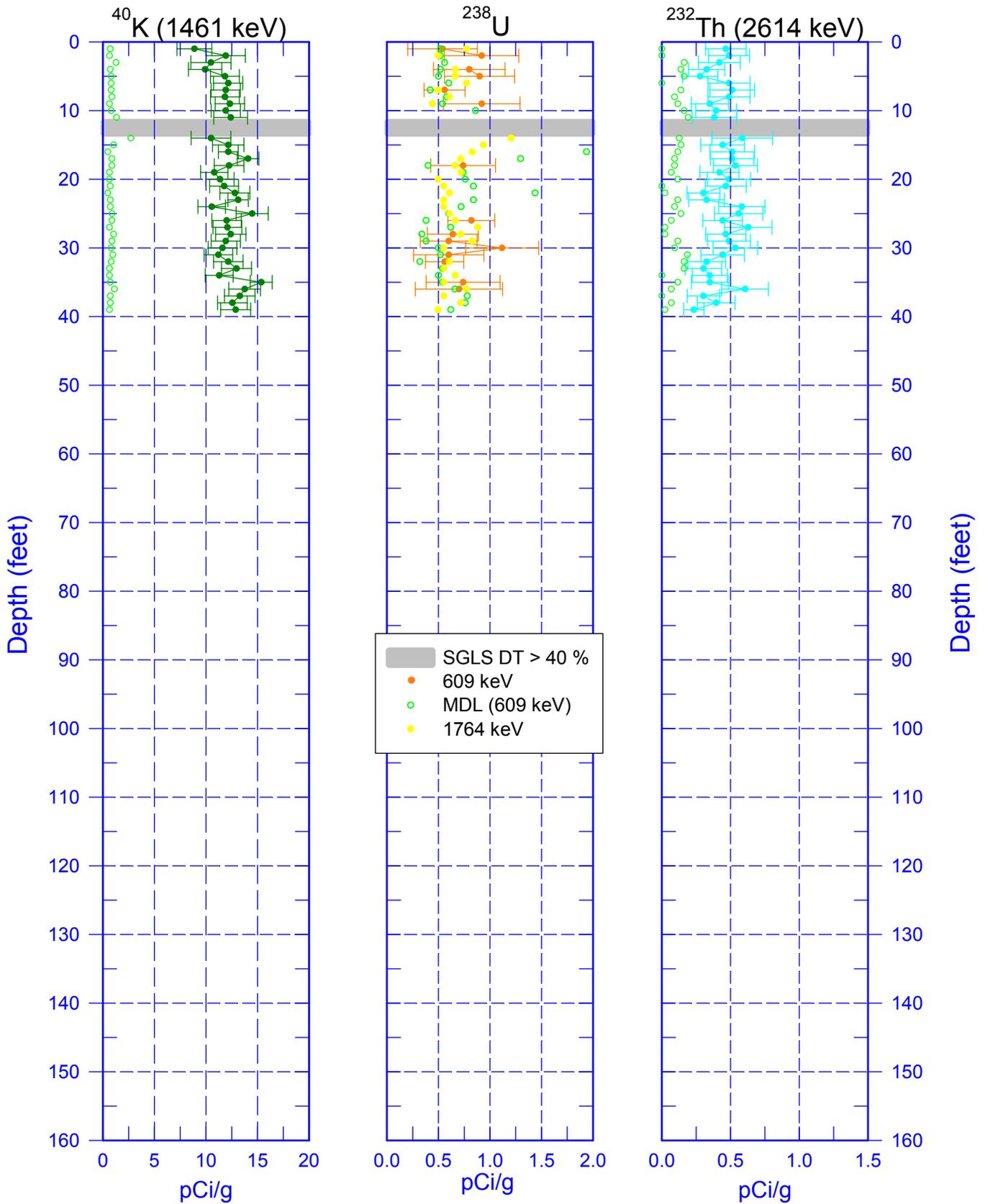
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## Man-Made Radionuclides



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## Natural Gamma Logs

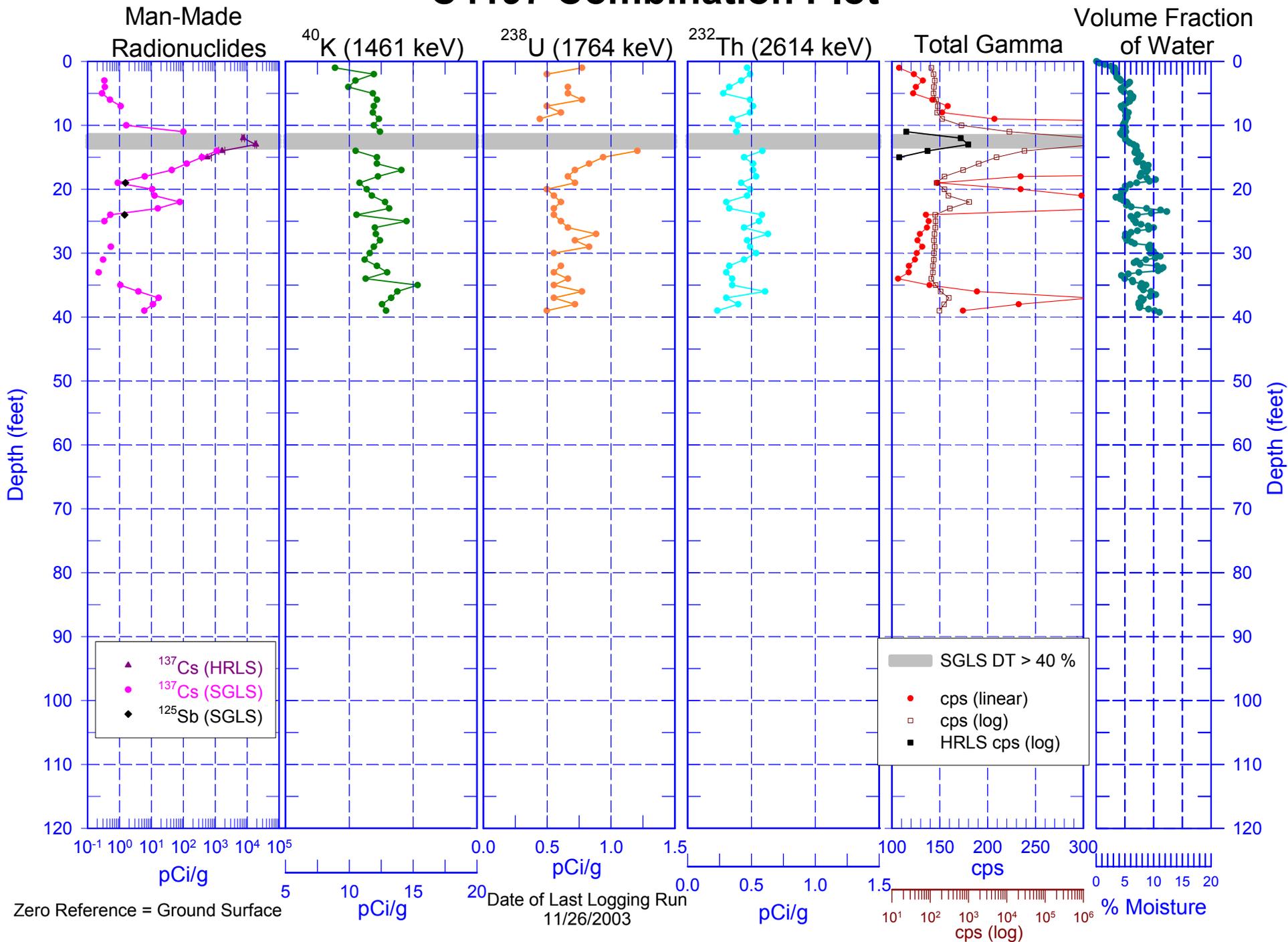


○ MDL

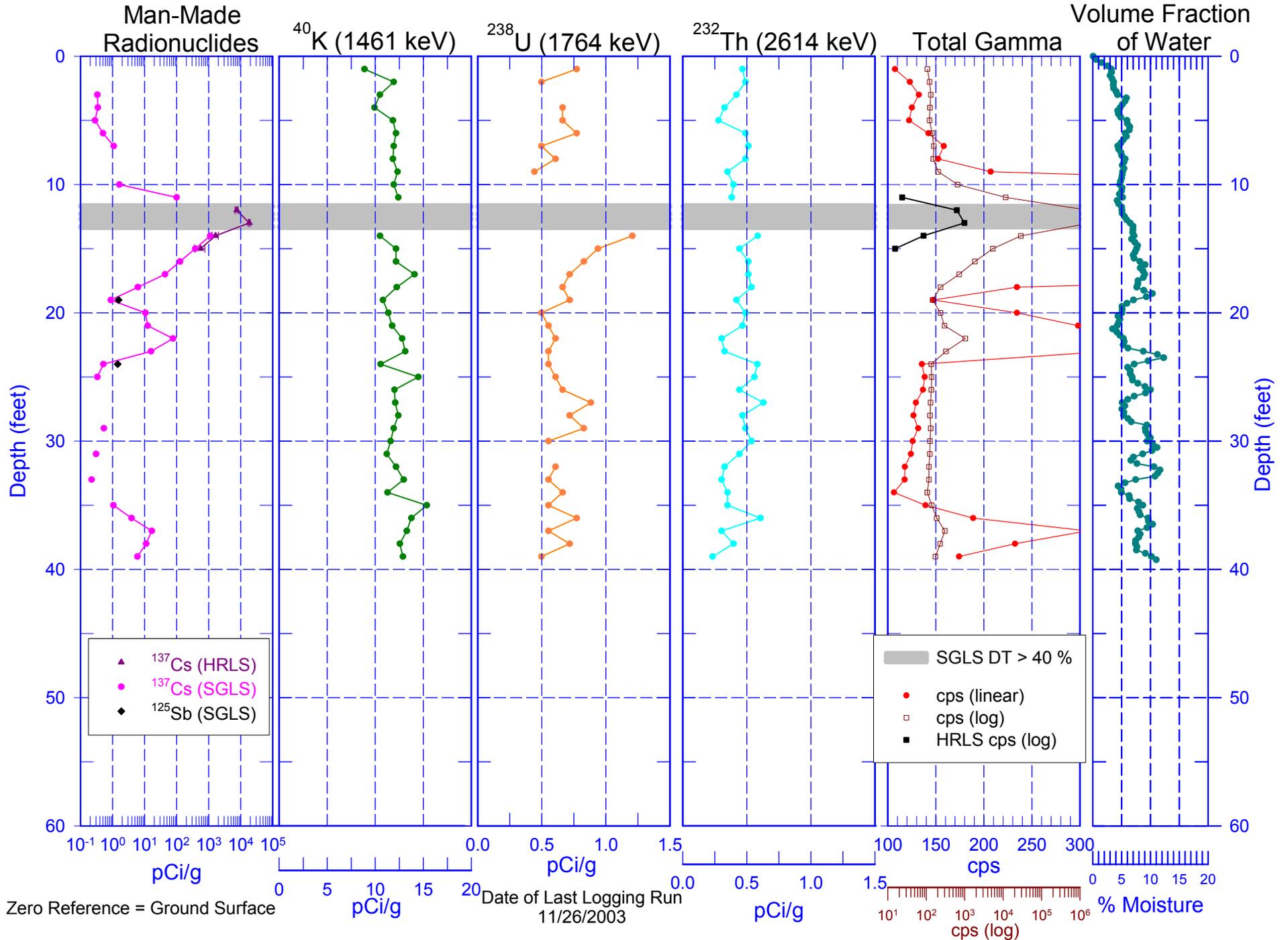
Zero Reference = Ground Surface

Date of Last Logging Run  
11/17/2003

# C4197 Combination Plot

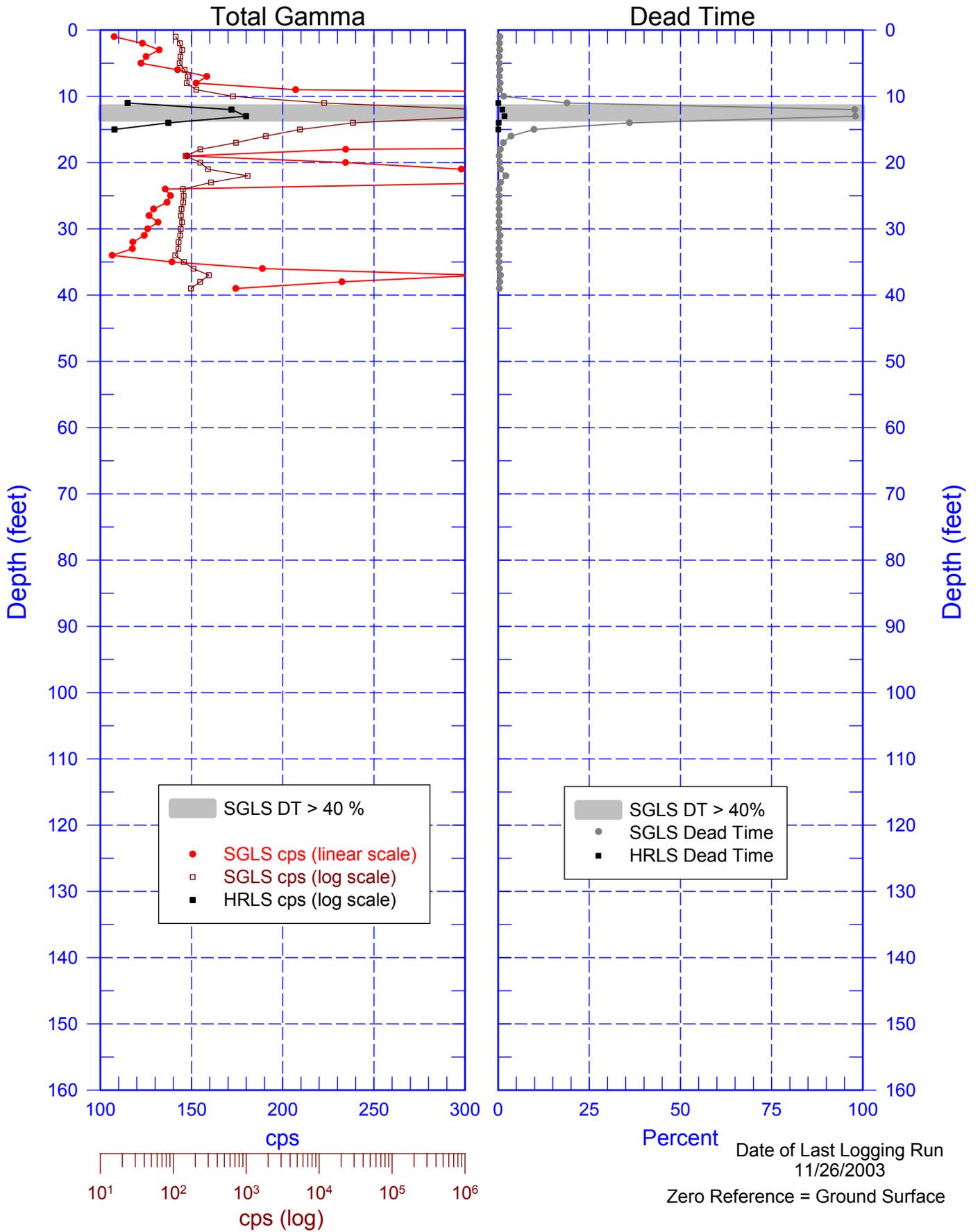


# C4197 Combination Plot



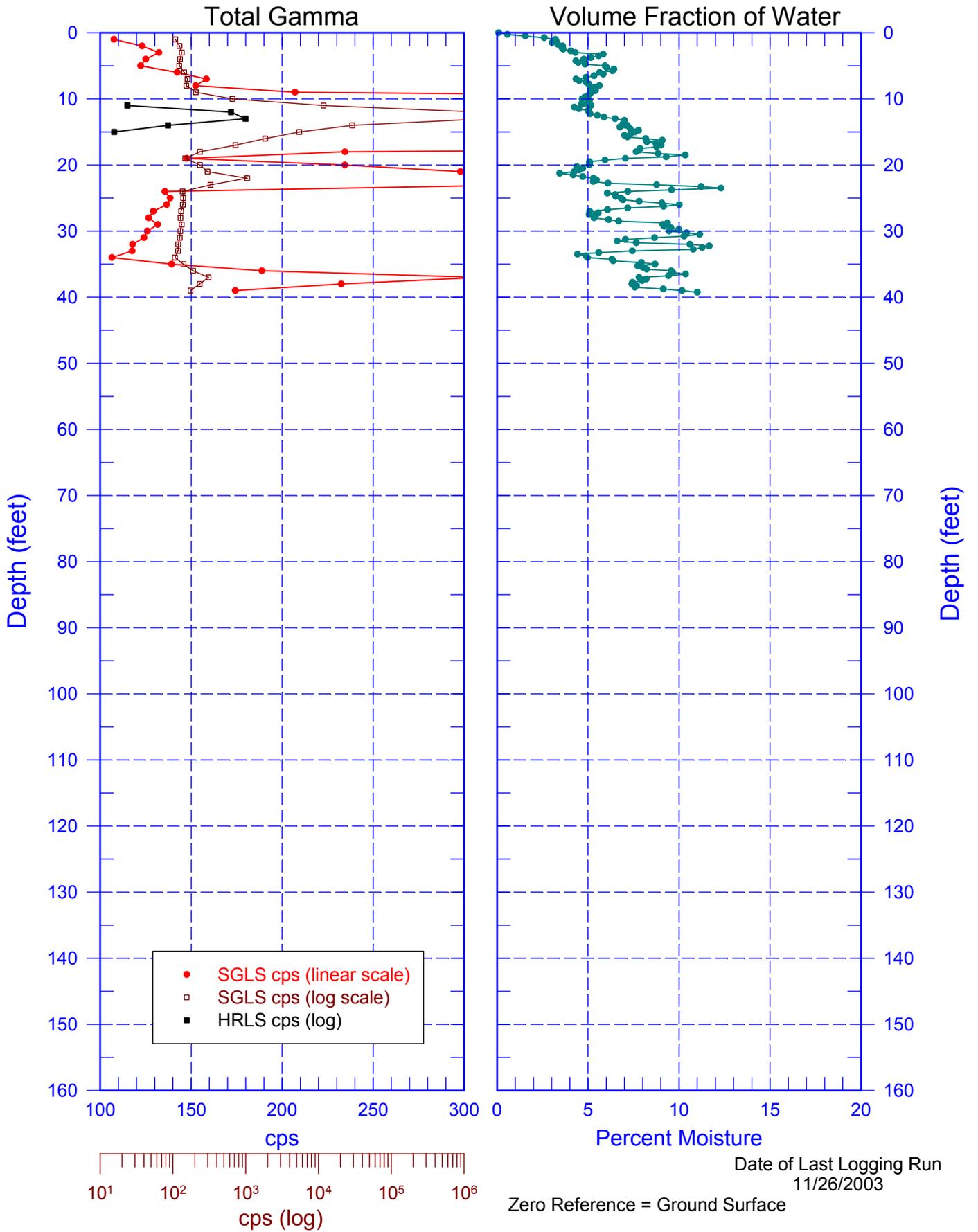
# C4197

## Total Gamma & Dead Time



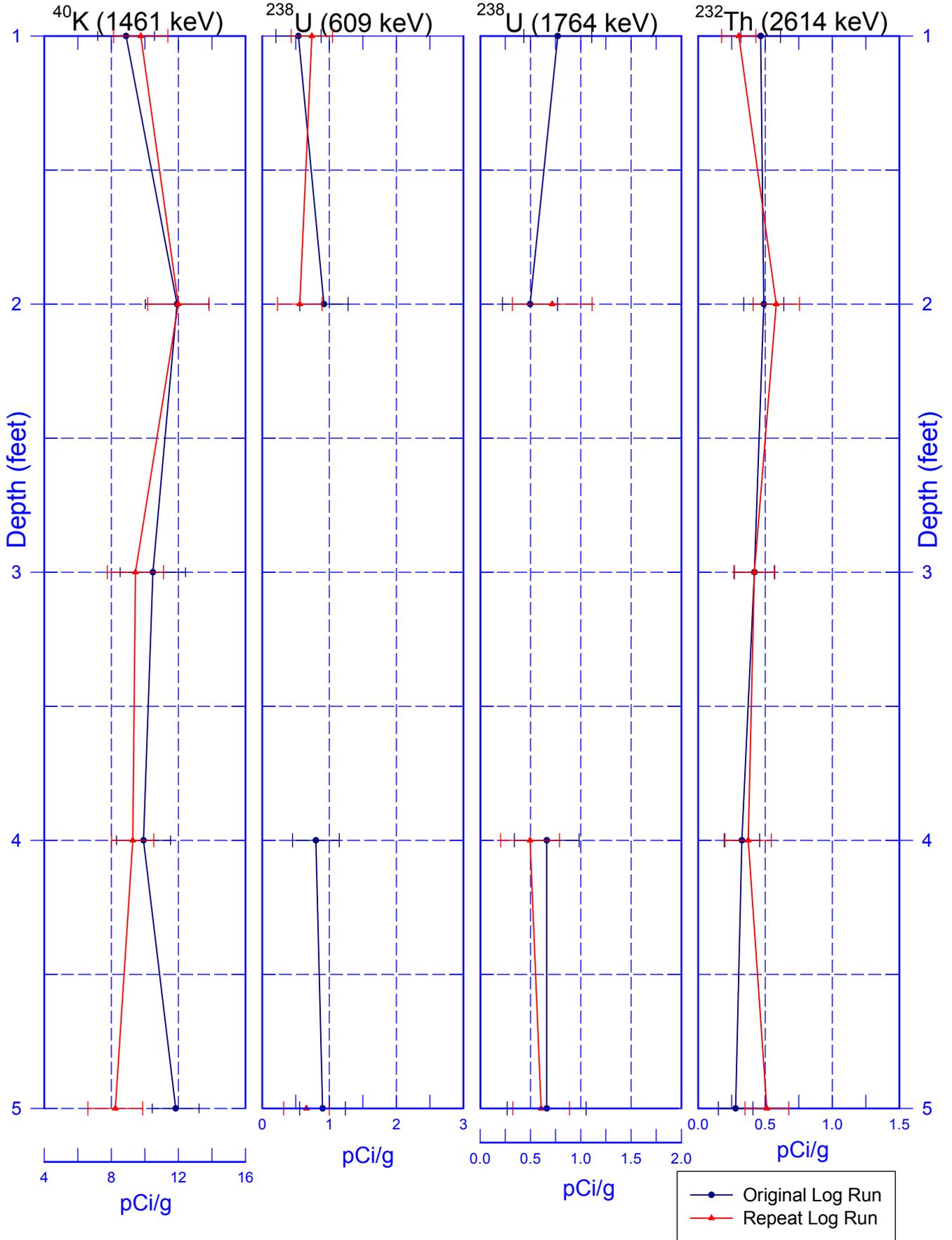
# C4197

## Total Gamma & Neutron



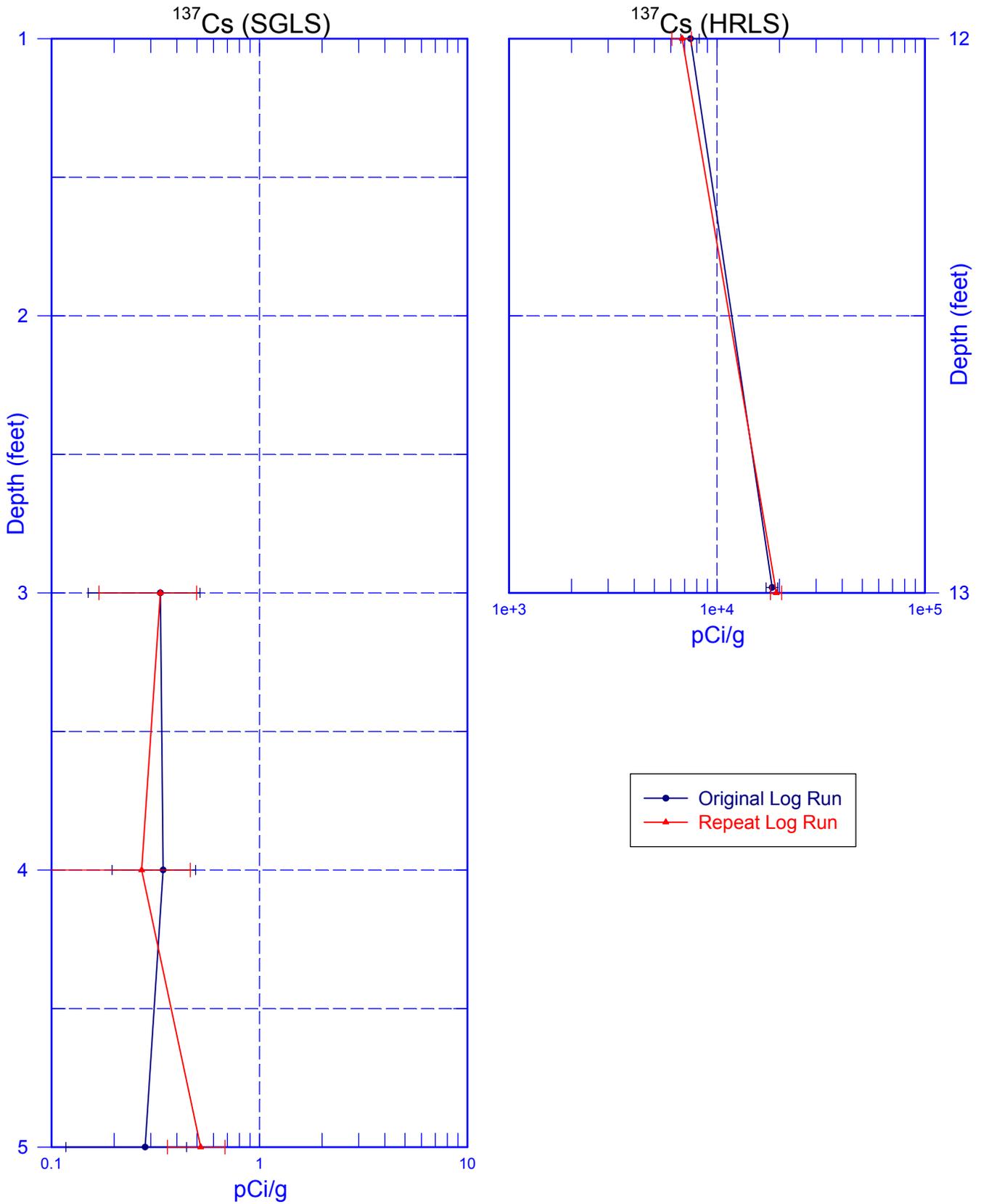
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## Rerun of Natural Gamma Logs (5.0 to 1.0 ft)



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## Rerun of Man-Made Radionuclides



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## Rerun of Neutron-Moisture Log (10.0 to 14.0 ft)

